International VLBI Service for Geodesy and Astrometry

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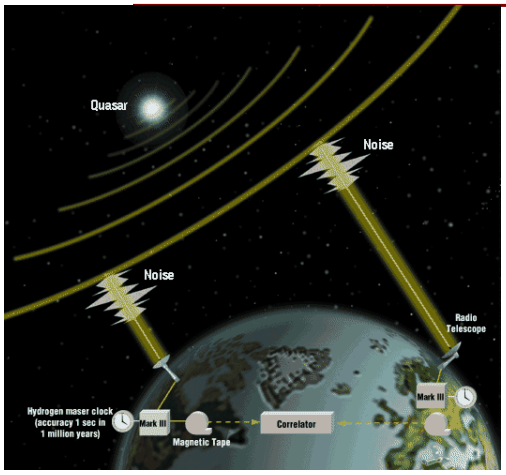
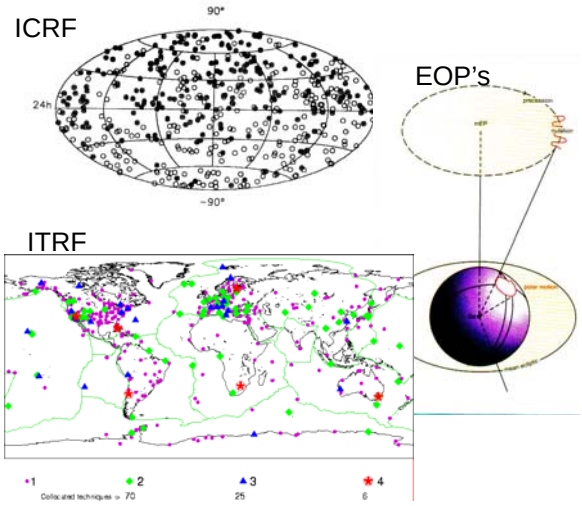
http://ivscc.gsfc.nasa.gov

Very Long Baseline Interferometry
- fundamental role -



- Unique Technique for
  - CRF
  - Celestial Pole
  - UT1-UTC
- Primary Technique for
  - EOP's (complete set of parameters)
  - TRF (most precise technique for long baselines)

Global Reference Frames and Related Products



- **ICRF:**
  - Radio Source Positions
- **ITRF:**
  - Station Positions
  - Velocities
- **EOP's:**
  - Celestial Pole ($d\varepsilon$, $d\psi$)
  - Polar Motion (x_P, y_P)
  - UT1-UTC (DUT1)
- Importance documented: coming up IAG Project **IGGOS** with demand for
  - mm-accuracy
  - consistent for decades
  - …..

I V S - International VLBI Service for Geodesy and Astrometry

IVS is a service of

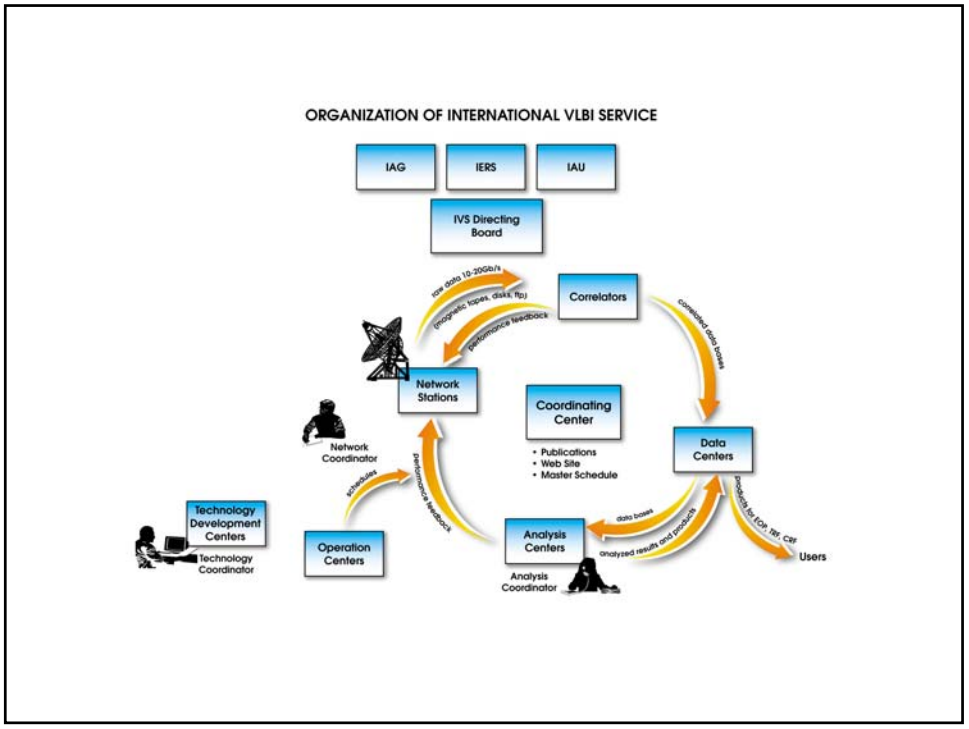
- **IAG** - International Association of Geodesy
- **IAU** - International Astronomical Union
- **FAGS** - Federation of Astronomical and Geophysical Data Analysis Services

IVS goals:

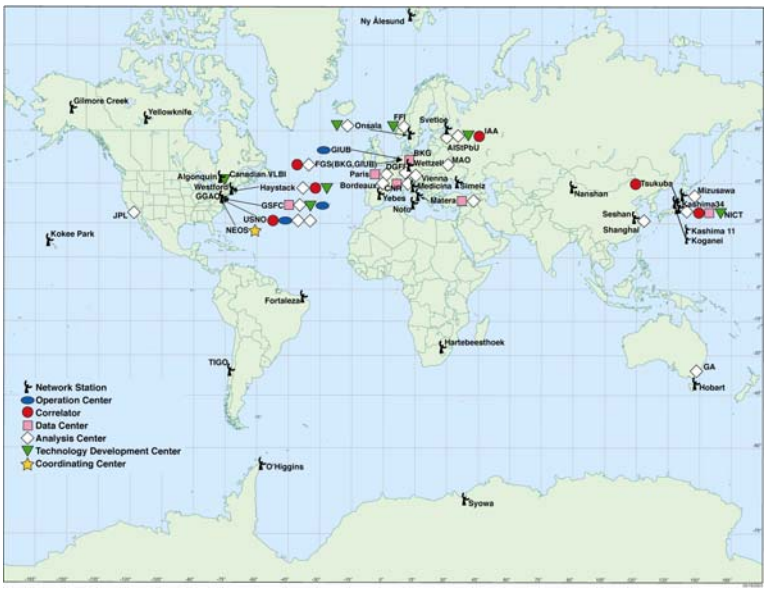
- To provide a service to support geodetic, geophysical and astrometric research and operational activities
- To promote research and development in the VLBI technique
- To interact with the community of users of VLBI products and to integrate VLBI into a global Earth observing system

Main tasks of the IVS are: coordinate VLBI components, guarantee provision of products for CRF, TRF and the set of EOP's

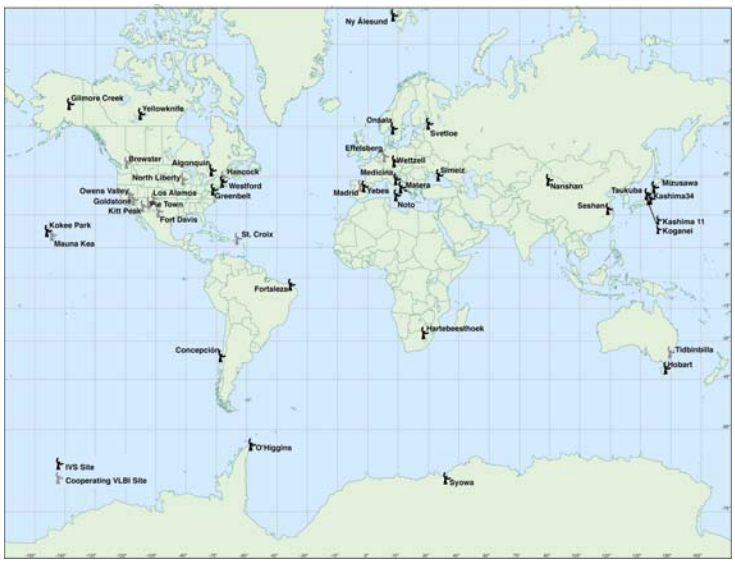
- IVS inauguration was on March 1st, 1999
- 74 Permanent Components supported by 37 institutions in 17 countries
- ~250 Associate Members



IVS Component Map



IVS Network Stations

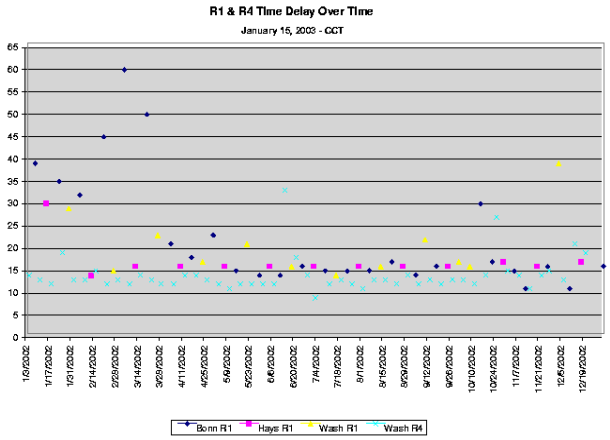


IVS Member Organizations

Australia	Geoscience Australia; University of Tasmania
Austria	Vienna University of Technology
Brazil	Centro de Rádio Astronomia e Aplicaçoes Espaciais
Canada	Space Geodynamics Laboratory; NRCan; Dominian Radio Astrophysical Observatory; Canadian Space Agency
Chile	Universidad de Concepción; Universidad del Bío Bío; Universidad Católica de la Santísima Concepción; Instituto Geográfico Militar de Chile
China	Chinese Academy of Sciences
France	Observatoire de Paris; Observatoire de Bordeaux
Germany	Deutsches Geodät. Forschungsinstitut; Bundesamt für Kartographie und Geodäsie; Geodetic Institute of the University of Bonn; Forschungseinrichtung Satellitengeodäsie (TU München)
Italy	Istituto di Radioastronomia CNR; Agenzia Spaziale Italiana
Japan	Geographical Survey Institute; National Institute of Information and Communications Technology; National Astronomical Observatory; National Institute of Polar Research
Norway	Norwegian Defence Research Establishment; Norwegian Mapping Authority
Russia	Astronomical Institute of St.-Petersburg University; Institute of Applied Astronomy
South Africa	Hartebeesthoek Radio Astronomy Observatory
Spain	Instituto Geográfico Nacional
Sweden	Chalmers University of Technology
Ukraine	National Academy of Sciences; Crimean Astrophysical Observatory
USA	NASA Goddard Space Flight Center; U.S. Naval Observatory; Jet Propulsion Laboratory

Delay from observation to product availability

Observation year: 2002



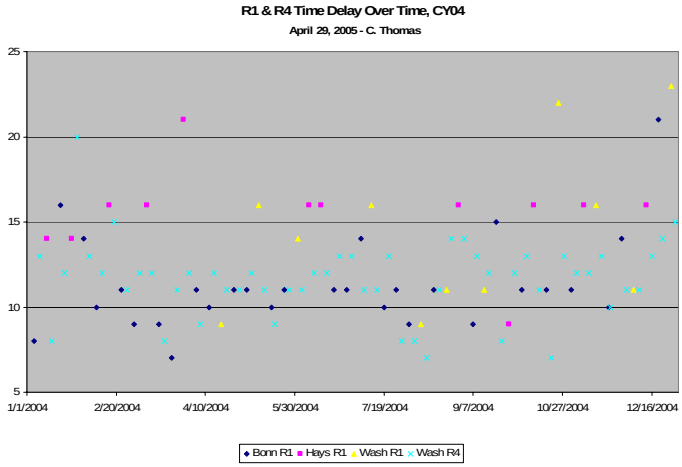
Two time series per week
- IVS R1
- IVS R4

Results available
- After approximately two weeks

Potential for Improvements
- Faster shipping
- e-VLBI
- Improved correlator processing factor

Delay from observation to product availability

Observation year: 2004



2005 Observing Plan Summary

Session purpose	Session code	Total # sessions (24 hr)	Avg # particip. stations	Total station days	Average GB recorded per station	Total TB per session	Total TB per year
Rapid turnaround EOP (Monday)	IVS-R1	52	6.9	358	1200	8.3	430
TRF, all stations 3-4 times / yr	IVS-T2	6	16.0	96	400	6.3	38
EOP, TRF using S2	IVS-E3	12	6.5	78	600	3.9	47
Rapid turnaround EOP (Thurs)	IVS-R4	52	6.8	356	500	3.4	178
CRF	IVS-CRF	6	3.2	19	400	1.3	8
CRF, emphasis on south	IVS-CRD	10	2.2	22	400	0.9	9
20-station EOP/TRF/CRF	RDV	6	10.5	63	1000	10.5	63
R&D Gigabit/s investigations	IVS-R&D	10	7.0	70	3000	21.0	210
Regional – Antarctica	IVS-OHIG	6	7.0	42	300	2.1	13
Regional – Europe	EURO	4	8.3	33	300	2.5	10
Regional – Asia/Pacific	APSG	2	6.0	12	300	2.0	4
Continuous VLBI (15 days)	CONT05	15	12.0	180	15000	180	180
1-hour EOP (253 days)	INT	–	2.0	21	35	0.0	0.1
	Total:	181		1350			1190.1

IVS Station Operations

- **Location of Stations**
  - some astronomical antennas also available occasionally for geodesy (e.g. Noto)
  - some built specifically for geodesy and located for geographic distribution (e.g. TIGO) or for convenience (e.g. Tsukuba)
  - southern hemisphere undersampled
- **Observing Priorities**
  - set by the Observing Program Committee based on guidance from IVS Working Group 2 report
  - highest priority to routine EOP measurements (twice weekly 24-hr sessions and daily 1-hr Intensive sessions)
  - all stations participate in TRF sessions 3-4 times per year
  - less frequent CRF sessions; some geodetic time used to monitor CRF
- **Scheduling, Coordination and Delivery**
  - Master Schedule made by IVS Coordinating Center (IVS CC)
  - individual observation schedules made by responsible Operation Centers
  - media logistics and correlator load coordinated by IVS CC
  - 24-hr rapid service EOP approx. 14 days delivery
  - 1-hr service EOP (Intensive) approx. 3-5 days delivery

IVS Products

Products		Current	Goals
Polar motion	accuracy	x_p~100 μas, y_p~200 μas	x_p,y_p: ~ 50…25 μas
	latency	1 – 4 weeks … 4 months	4 – 3 days … 1 day
	resolution	1 day	1 day … 1 h … 10 min
	frequency of sessions	~ 3 days/week	… 7 days/week
UT1	accuracy	5 … 20 μs	3 … 2 μs
	latency	0.5 - 1 week	4 – 3 days … 1 day
	resolution	1 day	1 day … 10 min
$\Delta\varepsilon$, $\Delta\psi$	accuracy	100 … 400 μas	50 … 25 μas
	latency	1 – 4 weeks … 4 months	4 – 3 days … 1 day
	resolution	1 day	1 day
	frequency of sessions	~ 3 days/week	… 7 days/week
TRF (x,y,z)	accuracy	5 – 20 mm	5 … 2 mm
CRF	accuracy	0.25 – 3 mas	0.25 mas (impr. distrib.)
	frequency of solution	1 year	1 year
	latency	3 – 6 months	3 … 1 month(s)

Future of IVS and VLBI

- Reduce time delay and reduce expenses
  - employment of a modern disc based recording system (Mark 5)
  - development of data transfer via the Internet (e-VLBI)
- Overcome weekend gaps
  - automation for unattended observing needed
  - employ VLBI Standard Interface
- Increase robustness of the products
  - more analysis centers with different software
- Improve Network Configuration
  - next VLBI generation (Vision 2010)
  - smaller antennas and fully digital back-ends
- Key issues
  - deterioration of the network due to aging equipment
  - suboptimal global distribution of the network stations
  - radio frequency interference (particularly on S-band)

VLBI2010

- **Working Group WG3:** established by IVS DB
- Motivation for a vision of the future:
  - Increasing requirements from GGOS/IAG
  - Severe RFI
  - Long turnaround times (compared to other techniques)
  - Aging antennas and equipment
- Issues to be explored for a new geodetic VLBI system:
  - Modern equipment, antennas, and observing strategies
  - Automated observing, remote monitoring
  - Electronic data transfer
  - Near real time correlation and analysis